annual rainfall; neither are extensive northern slopes, as, for instance, the northern half of Jackson County, where the average annual rainfall at Webster is only 35.98 inches (four years' record), although this record is considered rather doubtful.

The western portion of Macon County is not included in the area of 68 inches, as the average rainfall at Franklin is only 57.11. The record at Hendersonville, 66.14, being only for about one year, is of minor value. The most notable features of the distribution as to time are that the excess is due to heavy daily rains, and that there is an excess of rainy days in the summer season. Yet it is possible for severe droughts to occur, as in the summer of 1883 and the autumn of 1897. As a general rule in the winter season less snow falls than in the central portion of the State.

PHOTOGRAPHIC APPARATUS FOR MEASURING THE ALTITUDES ATTAINED BY BALLOONS.

By Prof. L. CAILLETET.

[Translated by the Editor from the Comptes-Rendu, Paris, October 26, 1897.]

I have the honor to present to the academy an apparatus, invented by myself, and which will undoubtedly enable us to solve an important question in physics, viz, the experimental verification of the formula of Laplace, relative to the readings of the barometer at various altitudes, by determining, by means of a photographic measurement, the height reached by the balloon that carries the barometer.

It has been already attempted to measure the height of a balloon by sighting upon it from each of the extremities of a base line whose length is known. In such cases, however, the balloon moves away and soon disappears.

I conceived the idea of replacing the observers on the ground by a photographic apparatus carried up by the balloon, and which would, at short intervals, automatically photograph the surface of the earth over which it passes, while at the same time the face of an aneroid barometer placed in front of a second object glass shall be photographed on the same plate.

This apparatus, which has been studied and constructed with great care by Mr. Gaumont, the skillful director of the General Photographic Company, is composed of a wooden prismatic box, suspended to the balloon in a manner that assures to its axis a sensibly vertical position. On the lower side, facing the ground, is placed an objective, suitably diaphragmed; upon the opposite side there is a second objective, intended to photograph the aneroid barometer, which is placed at a proper distance for obtaining a well-defined image on the sensitive surface. A clockwork movement causes the shutters to move, and these, by opening every two minutes, permit the rays of light to penetrate into the apparatus. A film of sensitive celluloid unrolls itself in front of the objectives, in obedience to a spring contained in a small, independent barrel, and receives upon its two sides the rays thus transmitted.

The dimensions of the proofs thus obtained are 0.13 by 0.18 meter; they give simultaneous observations of the ground, of the figures on the graduated circle of the barometer, and of its index.

When one knows (1) the focal length of the photographic objective, (2) the linear distance between any two given points on the ground, and (3) the linear distance of the same two points on the photographic plate, it is easy to determine, by a simple calculation in proportion, the height at which the balloon was at the moment when the photograph was taken. As this photograph gives also a view of the barometer and its index, and, consequently, of the pressure, we may thus experimentally determine the law connecting the barometric pressure of the atmosphere at various points with the altitudes of these points.

The possible error in the measurement of altitude will depend upon the accuracy of the determination of the focal length of the objective, on the one hand, and the measurement of the photograph, on the other. Now, it is easy to obtain these measurements to within about $\frac{1}{500}$, which would give an approximation of $\frac{1}{500}$ for the altitude determined with the photographic apparatus.

The apparatus thus described, and which had only been tried from the top of the Eifel Tower, has within the past few days been tested in an elevated balloon.

Thursday, October 21, the Aeronautic Committee of Paris made its first scientific ascension for the purpose of experimenting with various forms of self-registering apparatus intended for the contemplated ascensions of free balloons to very great altitudes.

A balloon made of silk, of 1,700 cubic meters capacity (generously offered to the Commission by M. Mascart, in the name of M. Balashoff), started from the gas works of La Villette at 12:40 p. m., and landed at 4:30 p. m. at Cossé-le-Vivien, in the Department of La Mayenne.

(Prince Roland Bonaparte, a member of the French Aeronautic Commission, kindly defrayed the expenses of this first ascension.)

The start and the landing of the aeronauts, Hermite and Besançon, were accomplished without accident, notwithstanding the violent gusts that rendered the preliminary maneuvers very difficult. The scientific apparatus, and especially the photographic apparatus above described, worked admirably. The altitude attained by the balloon was only 2,500 meters, which was due to circumstances over which the aeronauts had no control.

Twenty-six negatives were obtained, which reproduce very accurately the appearance of the ground below the path followed by the balloon. The position of the index of the barometer is shown with great precision in the center of each photograph. In a subsequent, more detailed description of the apparatus I shall explain the method of correcting the errors which may result from the contraction of the film while being dried.

When the photographic apparatus is to be taken up to great altitudes, all possible precautions are taken to prevent the stoppage of its mechanism and that of the barometer, which might be caused by the very low temperatures that we have already ascertained to exist in these elevated regions. Finally, besides the special use for which this photographic self-register was intended, I believe it will be of great service to aeronauts, enabling them, with the aid of a series of successive photographs, to determine the exact route followed by the balloon and to calculate the velocity of its horizontal movement at the various points of its course.

[Photographs from balloons and kites have doubtless been taken on many occasions, with various objects in view. Those made by Prof. S. A. King, the celebrated aeronaut, in Philadelphia, in 1884 and 1885, were studied with a view to the accurate determination of altitudes by the method adopted by Cailletet; but the results were not sufficiently encouraging. In fact, the accuracy of the altitudes and all other data must be greater than $\frac{1}{500}$ if they are to give us valuable information with regard to the reliability of the Laplacian formula. An uncertainty of plus or minus $\frac{1}{500}$ in the altitude is equivalent to an uncertainty of 0.06 inch in the pressure at 30,000 feet or 0.03 inch in the adopted pressure at 15,000 feet. A large amount of uncertainty may be introduced by other sources of disturbance, such as the moisture and the variation of gravity and the temperature of the barometer itself, but principally by the uncertainty as to the real temperature of the air below the balloon. In the case of data recorded at a mile high, as by the self-registers sent up with kites, the pressure and temperature can only be reduced to a uniform high level with any advantage when the altitude has been determined with an accuracy of $\frac{1}{500}$. In fact, the relation between pressure and temperature is at present as important for meteorology as the relation between these and the altitude. The trouble is not with Laplace's formula, but with the observational data that are adopted when we use that formula.—C. A.]

CLIMATOLOGICAL DATA FOR JAMAICA, W. I.

Through the kindness of Mr. Maxwell Hall, of Montego Bay, Jamaica, the meteorological service of that colony has acceded to the request of the Editor for the prompt communication of an abstract of the very interesting climatological records of that highly important West Indian service. The climatological summary for September, 1897, furnished by Mr. Hall, through his assistant, Mr. Robert Johnstone, of the Meteorological Office, is reproduced in the following table. For descriptive details of the stations and instruments see pages 308 and 356.

Jamaica, W. I., climatological data, September, 1897.

	Morant Point Lighthouse.	Negril Point Lighthouse.	Kingston.	Kings House.	Castleton Gardens.	Hope Gardens.	Stony Hill Reformatory.	Hill Gardens (Cin. Plant.)
Latitude	17°56′	18° 16′	17° 58′	...	18° 12′	...	...	18°05′
Longitude	76°10′	78° 23′	76° 48′	...	76° 50′	...	...	76°39′
Elevation (feet)	8	33	50	400	580	600	1,400	4,907
Mean barometer, 7 a. m.	29.913	...	29.927	...	29.595	29.24	...	25.359
Mean barometer, 3 p. m.	29.877	...	29.873	...	29.571	29.23	...	25.346
Mean temperature, 7 a. m.	83.0	...	76.4	73.4	70.9	73.2	73.1	62.9
Mean temperature, 3 p. m.	86.2	...	85.1	84.2	81.0	82.8	78.6	66.5
Mean of maxima	...	...	88.8	89.6	86.7	87.9	85.2	70.0
Mean of minima	...	...	73.9	67.3	67.3	69.8	72.2	59.5
Highest maximum	...	...	91.3	97	92	94	87	74
Lowest minimum	...	...	70.7	62	62	67	68	58
Mean dew-point, 7 a. m.	...	...	71.1	70.7	68.2	69.5	69.5	58.9
Mean dew-point, 3 p. m.	...	...	73.2	77.7	74.7	74.1	75.0	63.6
Mean relative humidity, 7 a. m.	...	...	84	93	88	90	88	86
Mean relative humidity, 3 p. m.	...	...	68	82	82	74	89	89
Monthly rainfall (inches)	6.62	...	8.84	10.40	17.15	10.43	16.06	11.32
Average daily wind movement	...	...	74.7	...	...	...	...	19.3
Average wind direction, 7 a. m.	var.	...	n.	...	...	...	...	e.
Average wind direction, 3 p. m.	var.	...	se.	...	...	...	...	e.
Average hourly velocity, 7 a. m.	...	...	1.3	...	...	...	...	16.5
Average hourly velocity, 3 p. m.	...	...	4.9	...	...	...	...	2.8
Average cloudiness (tenths):								
7 a. m., Lower clouds	2.9	...	1.0	...	...	...	...	...
7 a. m., Middle clouds	2.7	...	1.0	...	...	...	...	...
7 a. m., Upper clouds	1.5	...	4.4	...	...	...	...	...
3 p. m., Lower clouds	3.3	...	2.5	...	...	...	...	...
3 p. m., Middle clouds	2.2	...	1.0	...	...	...	...	...
3 p. m., Upper clouds	1.2	...	3.5	...	...	...	...	...
OCTOBER, 1897.								
Mean barometer, 7 a. m.	29.868	...	29.857	...	29.550	29.18	...	25.326
Mean barometer, 3 p. m.	29.820	...	29.826	...	29.520	29.19	...	25.308
Mean temperature, 7 a. m.	78.7	...	74.2	73.1	71.1	71.5	72.7	61.9
Mean temperature, 3 p. m.	83.1	...	82.2	81.4	79.0	80.2	76.3	64.5
Mean of maxima	...	...	85.4	86.7	84.6	83.9	82.8	68.4
Mean of minima	...	...	72.2	66.3	68.1	68.4	68.9	58.2
Highest maximum	...	...	90.9	92	89	90	88	73
Lowest minimum	...	...	70.3	61	66	66	67	55
Mean dew-point, 7 a. m.	...	...	71.4	71.0	68.8	69.7	70.0	58.9
Mean dew-point, 3 p. m.	...	...	73.1	75.6	72.9	74.4	72.9	61.6
Mean relative humidity, 7 a. m.	...	...	91	93	90	93	91	87
Mean relative humidity, 3 p. m.	...	...	76	84	78	82	89	90
Monthly rainfall (inches)	25.08	...	23.45	28.75	20.88	24.60	24.97	32.93
Average daily wind movement	...	...	32.8	...	...	...	...	38.8
Average wind direction, 7 a. m.	var.	...	n.	...	...	...	...	se.
Average wind direction, 3 p. m.	var.	...	se.by s	...	...	...	...	se.
Average hourly velocity, 7 a. m.	4.7	...	0.1	...	...	...	...	...
Average hourly velocity, 3 p. m.	8.8	...	3.5	...	...	...	...	...
Average cloudiness (tenths):								
7 a. m., Lower clouds	4.4	...	2.5	...	...	...	...	...
7 a. m., Middle clouds	1.5	...	1.1	...	...	...	...	...
7 a. m., Upper clouds	1.0	...	2.3	...	...	...	...	...
3 p. m., Lower clouds	4.6	...	3.5	...	...	...	...	...
3 p. m., Middle clouds	1.9	...	1.1	...	...	...	...	...
3 p. m., Upper clouds	1.3	...	2.8	...	...	...	...	...

MEXICAN CLIMATOLOGICAL DATA.

Through the kind cooperation of Señor Mariano Bárcena, Director, and Señor José Zendejas, vice-director, of the Central Meteorologico-Magnetic Observatory, the monthly summaries of Mexican data are now communicated in manuscript, in advance of their publication in the *Boletin Mensual;* an abstract translated into English measures is here given in continuation of the similar tables published in the MONTHLY WEATHER REVIEW during 1896. The barometric means have not been reduced to standard gravity, but this correction will be given at some future date when the pressures are published on our Chart IV.

Mexican data for October, 1897.

Stations.	Altitude.	Mean barometer.	Temperature.			Relative humidity.	Precipitation.	Prevailing direction.	
			Max.	Min.	Mean.			Wind.	Cloud.
	Feet.	*Inch.*	° *F.*	° *F.*	° *F.*	%	*Inch.*		
Arteaga (Coahuila)	...	...	86.4	43.5	67.6	...	...	...	...
Barousse	5,414	...	78.3	37.6	65.3	...	...	...	...
Colima	1,656	...	...	...	80.6	...	...	...	...
Leon	5,934	24.29	81.7	46.6	64.4	57	0.38	sw.	e.
Linares (New Leon)	1,188	28.75	90.7	51.8	77.9	74	1.46	se.	...
Magdalena (Sonora)	4,948	...	...	...	74.8	...	0.71	sw.	n.
Merida	50	29.87	97.8	63.5	78.6	78	5.51	ne.	w.
Mexico (Obs. Cent.)	7,472	23.08	75.2	45.0	60.3	68	0.97	nnw.	ne.
Monterey	1,626	28.18	89.6	53.6	71.8	68	1.19	e.	w.
Morelia (Seminario)	6,401	23.97	79.9	50.0	64.9	73	0.66	ssw.	ene.
Parras (Coahuila)	3,986	...	82.8	51.6	69.3	...	...	...	...
Puebla (Col. Cat.)	7,112	23.36	80.6	38.3	63.9	60	0.22	nne.	ne.
Saltillo (Col. S. Juan)	5,399	24.86	79.5	44.6	64.2	59	0.24	sw.	n.
Torreon (Coahuila)	3,720	...	92.1	55.8	76.5	...	...	...	...
Vaqueria (Coahuila)	...	...	87.4	50.4	63.7	...	...	...	...
Zacatecas	8,015	22.53	80.6	39.9	60.8	59	0.47	e.	e.

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